Mythological creatures: Teaching science through icons of ancient culture

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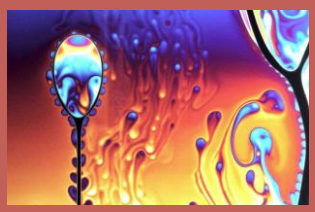
Service Courses in Science

In any gathering of science teachers (including WCSE), much of the dialogue will tend to focus on teaching practices in core science courses, aimed primarily at science majors (and rightfully so).

But today, I would like to explore some of the challenges posed in teaching science to a primarily non-science student population (mostly in the Arts and Humanities).



Teaching a Service Course

Service courses provide unique teaching opportunities in bridging academic disciplines both within and beyond the traditional boundaries of science.

The first year undergraduate level course Earth Sciences 1089G: Earth, Art and Culture, aims to impress upon students relationships between science and culture.

Examples primarily (but not exclusively) drawn from examples in the geosciences, but a similar approach is applicable to other science disciplines.

Some challenges posed in teaching a science course to primarily non-Science students (mostly Arts & Humanities)

Many non-science students who enroll in ES1089G (Earth, Art and Culture):

1. Are scared about taking a university-level science course (not just scared - I mean reaaallly scared). Most have tried their hardest to avoid taking senior science courses in high school.

2. Have already convinced themselves that they will struggle in the course (so are subject to intense mind-block)

3. Take the course grudgingly (owing to being forced to take a science course for their breadth requirement for graduation).

Much of the dread possessed by non-science students in taking a university-level science course is due to misconceptions about science.

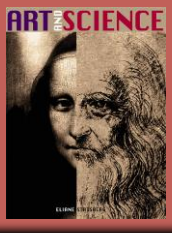
These include notions that science:

1. Involves no creativity or emotion
2. Requires superior intelligence and an advanced command of technology
3. Involves the use of a strict "scientific method" that only scientists understand (and which involve experiments with scary apparatuses)
4. Does not tolerate mistakes
5. Yields no surprises

Something I constantly struggle with:

Interestingly, some Arts & Humanities students have claimed to me that they grasp concepts more effectively when key messages are allowed to "naturally emerge" from whatever is taught – to obtain more of a "gut feeling" affinity to the material.

So how do we deal with this one (as it tends to work against the traditional approach to teaching science)



Involves re-thinking context and teaching style

Present exciting challenges for experimentation

Science and Myth

One of the most popular topics covered in the course concerns the origin of ancient myths, namely those featuring fantastical beasts featured in myth.

An unusual, but useful, context in which to explore and appreciate the roots of scientific inquiry in rational thought and as a means of dispelling some of the misconceptions that non-science students have about the nature of science itself.

Myths and mythical creatures are featured in virtually every culture in the world.

How do they originate?

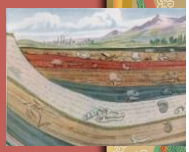
Are they the products of overactive imaginations, or might they be based on a grain of truth?

Fossils: Different meanings for different people?

To geologists, fossils (evidence of ancient life), provide important information on how life developed through time (evolution), aspects of ancient sedimentary environments, and are the basis for the subdivision of rocks into "time slices" for purposes of dating geologic events.

But in the eyes of others, fossils can be viewed as representing other things (the work of the devil, for instance)

Such misunderstandings in parts of modern society make one wonder how fossils might have been viewed even further back in time… by ancient people.



While it is easy to dismiss mythical creatures as products of overactive imaginations, it is not difficult to imagine how some might have developed from early interpretations of fossils.

The Gryphon/Gryphin/Griffin

The gryphon, one of the oldest mythical creatures, has existed for at least 5,000 years in human culture.

Main features: the body of a lion and the head and wings of an eagle

Gold prospectors beware !

These winged monsters would find gold in the mountains and built nests from it (this lured hunters, so griffins kept hostile guard over their nests, in which their stone eggs were contained).

The men and horses who came too close to the nests would be killed promptly.

.

Modern version of the "gryphon egg" in attractive blue crystal

(by Faberge)

Fierce, but trainable

Gryphons are also said to have pulled the chariots of the gods (as depicted in Greek and Roman art).

The gryphon's image is geographically widespread.

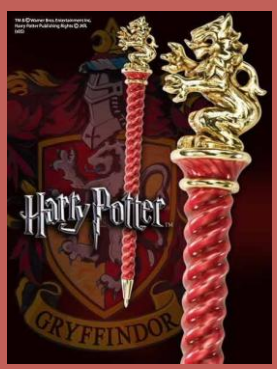
The gryphon is featured in artifacts from Egypt, Mesopotamia, Greece, and India, is commonly represented in gargoyles, and is a popular image in modern culture.

Coat of arms, Griffin family (Ireland)

Gargoyle on condo roof, Long Beach, California

Vauxhall Auto logo

And of course…



Need we say more?

An interesting point made by Adrienne Mayor
Author of The First Fossil Hunters:
Paleontology in Greek and Roman Times)
Princeton University Press, 2000

The Greeks claimed that the gryphon generally resided in India

However…gold artifacts (decorated with gryphons) excavated in the 1940s by Soviet archeologist Sergei Rudenko suggest that the idea of the gryphon probably originated in western Asia (probably in the Gobi desert region).

Exactly what in the Gobi Desert might have spawned the Gryphon myth?

To appreciate this, let's imagine ourselves as nomads travelling in the harsh Gobi desert.

As we travel further into this seemingly inhospitable land, we are faced with constant reminders of death

Roadkill Bingo in Ancient Times

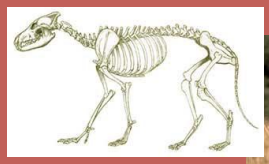
Perhaps along the way, we encounter the remains of familiar animals.

Having both butchered animals for food and observed the bones of others protruding from dead animals, we can identify many of these remains.

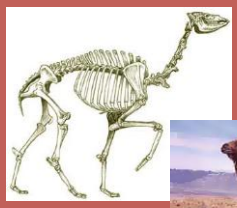
Let's see how good we are at this!

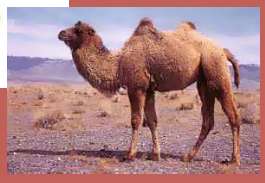
(I'll attempt to read your thoughts in the process)

Wolf

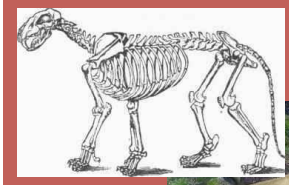


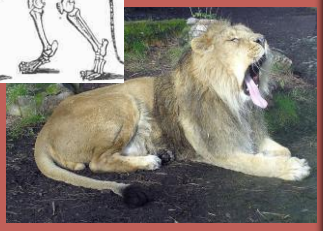
Camel





Lion





Eagle

WTF??!!

…and voila!

Modern Interpretation

This creature is recognized today as the dinosaur *Protoceratops*

Comparison of *Protoceratops* and the Gryphon

Protoceratops features:

1. Compact skull with a strong beak (used for snipping vegetation), and delicate frill with a lower chance of being preserved than the rest of the skull.
2. A squat body with a long tail and four legs (so might be deemed similar to a lion, although it was a reptile).

The mythical gryphon

Protoceratops: the real "gryphon ?"

Protoceratops features, cont'd

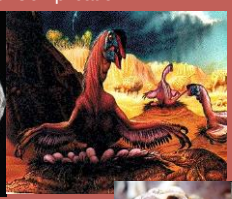
3. Could the long shoulder blades of Protoceratops have been misinterpreted as attachment bases for wings?

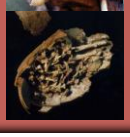
What about the famed nests ?

Also found in the dinosaur-bearing sandstones of Gobi desert are dinosaur nests, some containing fossil eggs.

Are the fossil eggs "stone eggs" of the gryphon ?

A Small Complication





It was assumed that all of the nests were made by *Protoceratops.*

Later investigations indicated that at least some nests were made by the carnivorous dinosaur *Oviraptor* (containing unhatched *Oviraptor* babies).

One such nest preserves the skeleton of an adult *Oviraptor* fossilized in the act of protecting its nest.

Oviraptor: Another possible candidate for the real "gryphon ?"

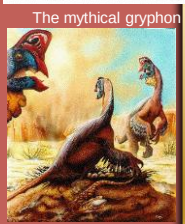
The direct association of *Oviraptor* with fossil eggs might suggest that it was the remains of *Oviraptor*, not *Protoceratops* that spawned the gryphon myth.

Note that *Oviraptor* too had a beak-like snout and a long tail.

However…*Oviraptor* was bipedal (walked on two long back legs), not quadripedal, so *Protoceratops* remains a contender.

Another possibility: The gryphon myth was fabricated from findings of the remains of both *Protoceratops* and *Oviraptor*.

The mythical gryphon



Oviraptor: the real "gryphon ?"

The supposed occurrence of gold in gryphon nests may too be related to geologic factors.

1. The sand grains composing the dino-bearing sandstone were probably derived from the weathering and erosion of sedimentary rocks (some of which are known to contain placer gold and platinum).

2. In many sand dune fields, erosion is concentrated in the low, unvegetated, areas between sand dunes. Through the sorting action of wind, light sedimentary particles (e.g. quartz grains) are preferentially blown away, while heavy sedimentary particles are left behind (as wind placer deposits).

Is it possible that early gold prospectors actively sought out fossil dinosaur nests with the knowledge that they were commonly associated with local concentrations of gold ?

You really gotta wonder (would be really cool if they did)!

So…

Protoceratops (and/or *Oviraptor*) remains
+
Nests containing fossilized dinosaur eggs
+
Gold concentrations in dinosaur nest areas
+
Lots of imagination

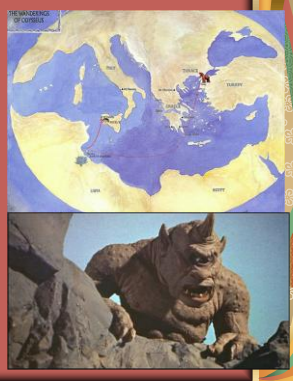
= gryphon myth

The Cyclops

The Cyclops is another mythical beast that may be rooted in a grain of truth.

Homer's famous tale of the adventures of Odysseus during his 10-year return trip from Troy to his homeland, features a band of one-eyed giants called the Cyclopes on Sicily.

While searching for supplies on an island, several men of are captured and eaten by one of the Cyclopes.



Mything details

There were two generations of Cyclopes:

The first generation consisted of three brothers, Brontes ("thunderer"), Steropes ("flasher"), and Arges ("brightener"), who came from the union of Gaia (earth) and Uranus (sky).

Skilled metal workers - created Zeus' thunderbolts, Poseidon's trident, and Hades' Helmet of Darkness that was later used to decapitate Medusa.

The second generation descended from Poseidon and the sea nymph Thoosa (most famous, in Odyssey).

Disillusioned band of outlaws disowned by their family (explains why they were so nasty).

The Secret to Surviving a Cyclops Attack: Alcohol!

The survivors escape the clutches of the Cyclops by getting getting the monster drunk, and blinding it.

Another scenario: Let's visit the ancient Greeks (pre- 8th century B.C.E.)

We are sailing in a small Greek ship in the Mediterranean Sea, pushed along by the wind.

Dangers abound- weather can change suddenly, and there can be fierce wild animals on the islands we are exploring.

Hopefully, our prayers to Poseidon have been heard.

We have already landed on a number of small islands in the Mediterranean, and it is not uncommon to find the remains of familiar animals.

…But with one exception.

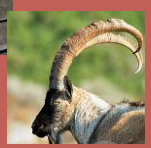
Let's consider some of the remains of animals that might have been encountered by ancient travellers in the Mediterranean.

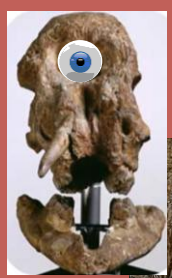
Seal

Monkey

Lion

Goat



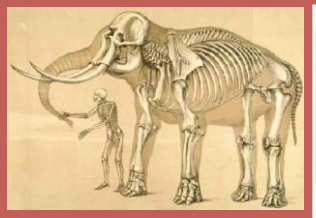


???!!!

Damn you, Poseidon!

It is very possible that the Cyclops myth is based on fossil remains of an extinct relative of the modern elephants.

Tens of thousands of years ago, many islands of the Mediterranean were inhabited by Dwarf Elephants (believed to have island hopped from Turkey during times of low sea-level)



Fossil skull of dwarf elephant

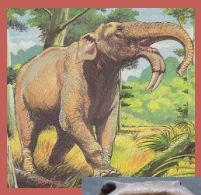
Could this be our Cyclops?
Maybe too small?

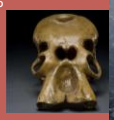
…or maybe something bigger?

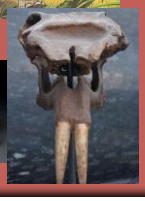
Remains of an ancient mammals called deinotheres are widespread throughout Europe, Asia and Africa, preserved in rocks ranging in age from 1.8 to 23 million years old.

Recently, remains of an exceptionally large deinothere species called *Deinotherium giganteum* were found on the island of Crete.

This animal was an incredible 4.5 metres tall at the shoulder and unlike modern elephants possessed two tusks in its lower jaw.



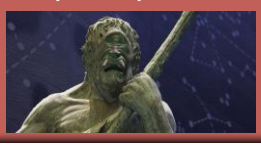




Connecting the Pieces

Remains of a huge, bulky creature
+
…with a very big hole in the centre of its head
+
…on a Mediterranean Island
+
…some imagination

…suggests a very strong connection to the Cyclops myth, don't you think ?



Hallucigenia: A near-myth

Hallucigenia is an extinct, 0.5-3.0 cm-long, fossil animal found in the 505 million year old Burgess Shale of British Columbia. Canada

Owing to its weirdness, and its timing of appearance in the fossil record (shortly following the so-called Cambrian explosion- the dramatic diversification of complex, multicellular animals), this tiny critter has attracted a disproportionately large amount of scientific press relative to other invertebrates.

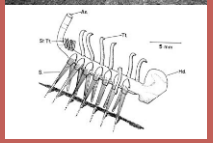
Originally discovered and called a "worm" by Charles Walcott in 1911, *Hallucigenia* was given its unusual name by Simon Conway Morris (Cambridge University) when he re-examined Walcott's specimens in the late 1970s (about 30 specimens known).

Nothing in the anatomy of *Hallucigenia* made sense in the context of the animals, either living or fossil, known at that time:

Visible features:

- Two rows of spines on one side of the animal
- One row of tentacle-like appendages on the other
- A tube-like thingie at one end
- A "blob" at the other end

Problems in Interpreting *Hallucigenia*



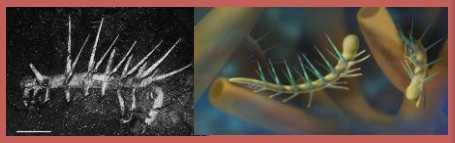
1. Tentacles look like legs, but are not paired as would be required for walking.
   Tentative interpretation: The spines served as the animal's (awkward) legs
2. No distinct head…or mouth visible
   How did it eat?
   Tentative interpretation: the "blob" was a head (but this lacked a mouth), and feeding was accomplished by the single row of tentacular appendages.

The big flip

In 1991, Lars Ramskold and Hou Xianguang, found a *Hallucigenia*-like fossil (called *Microdictyon)* in the Maotianshan Shales of China that showed the pairing of pincer-tipped legs, identifying it as a member of the group of organisms called onychophorans (so-called “velvet worms”)

Upside down…backward even?

Re-examination of *Hallucigenia* similarly revealed a second row of “tentacles” that were ultimately re-interpreted as legs.



It has also been suggested that the blob (or just a blob of leaked bodily fluids) may be the tail and the tubular end may be the head.

So even today, it is possible for scientists to make huge errors in their interpretation of fossils.

What messages emerge from this comparison and contrast of pre-scientific versus modern scientific accounts of fossil remains?

Current understanding of the natural world embodies:

1) The inherent tendency of humans to seek rational explanations for perplexing observations (as reflected in both pre-scientific and scientific interpretations of natural features).

2) The development of scientific inquiry as an objective approach to formulating explanations for observations (thus supplanting the supernatural elements of ancient accounts).

3) The accumulation of knowledge amassed since ancient times through the addition of new observations and the further testing of hypotheses.

Other topics of discussion?

What distinguishes science from myth?

Scientific approach	Myth
Based on observations	Can be based on observations (but can involve unobservable elements)
Involves formulation of hypothesis (possible explanation)	Involves formulation of explanation
Hypothesis tested by experiment and/or comparision with additional observations	Testability not required
Results are tentative	“Just-so,” not meant to be questioned
Further testing and revision encouraged	Further testing not necessarily encouraged, but can be subject to some revision

Differences in background knowledge available for interpreting fossils

Ancient times	Modern day
Present-day organisms	Present-day organisms Fossil organisms Concepts of: Geologic time Evolution Extinction Processes of fossilization Tectonic activity Mineral formation Etc., etc.

Modern scientists have a much larger amount of accumulated knowledge at their disposal (so scientists have no cause to be smug about how easily observations on fossils can be realistically interpreted)

What else is conveyed?

Misconceptions revisited:

1. ~~Involves no creativity or emotion~~
2. ~~Requires superior intelligence and an advanced command of technology~~
3. ~~Involves the use of a strict “scientific method” that only scientists understand (and which involve experiments with scary apparatuses)~~
4. ~~Does not tolerate mistakes~~
5. ~~Yields no surprises~~

Maybe we’re not so different after all!

End of presentation